"The Land Cover component of the ESA Climate Change Initiative. Extending the series of global land cover maps to 2015 with PROBA-V: current achievements."

Defourny, Pierre ; Bontemps, Sophie ; Lamarche, Celine ; Brockmann, Carsten ; Achard, Frédéric ; Boettcher, Martin ; De Maet, Thomas ; Gamba, Paolo ; Hagemann, Stephan

Abstract

Essential Climate Variables (ECVs) were listed by the Global Climate Observing System (GCOS) as critical information to further understand the climate system and support climate modelling. In response, the European Space Agency (ESA) launched its Climate Change Initiative (CCI) in order to deliver global datasets matching the need for long-term satellite-based products for the climate domain. The ESA Land Cover CCI (LC_CCI) project, dedicated to the Land Cover ECV, built on the ESA-GlobCover experiences to revisit all algorithms required for the generation of global LC products from various Earth Observation (EO) instruments that meet the needs of key users of the climate modelling community. The first phase of the LC_CCI project delivered a new generation of satellite-derived global land cover products consisting in three maps at 300 m spatial resolution for three epochs centered on the years 2010 (2008-2012), 2005 (2003-2007) and 2000 (1998-2002). These maps were obtained from SPOT...

Document type : *Communication à un colloque (Conference Paper)*

THE LAND COVER COMPONENT OF THE ESA CLIMATE CHANGE INITIATIVE

EXTENDING THE SERIES OF GLOBAL LAND COVER MAPS TO 2015 WITH PROBA-V: CURRENT ACHIEVEMENTS

Defourny P. (1), Bontemps S. (1), Brockmann C. (3), Achard F. (2), Boettcher M. (3), De Maet T. (1), Gamba P. (4), Hagemann S. (5), Hartley A. (6) , Hoffman L., (11), Khlystova I.G. (5), Kirches G. (3), Lamarche C. (1), Lisini G. (4), MacBean N. (7), Mallick K. (11), Mayaux P. (2), Moreau I. (1), Pathe C. (8), Peylin P. (7), Radoux J. (1), Ramoino F. (10), Riedel T. (8), Santoro M. (9), Schmullius C. (8), Smollich S. (4), Van Bogaert E. (1), Wegmüller U. (9), Vittek M. (1), Zuehlke M. (3), Arino O. (10)

(1) UCLouvain-Geomatics, Belgium; (2) JRC, Italy; (3) Brockmann Consult GmbH, Germany;
(4) University of Pavia, Italy; (5) Max Plank Institute for Meteorology, Germany;
(6) MET Office, United Kingdom; (7) LSCE, France; (8) University of Jena, Germany;
(9) GAMMA Remote Sensing, Switzerland; (10) ESA, Italy, (11) LIST, Luxemburg

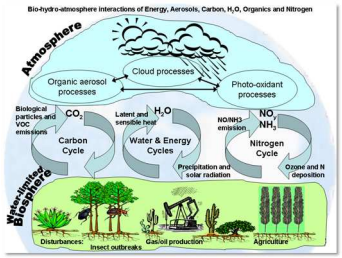
UCL – EARTH & LIFE INSTITUTE

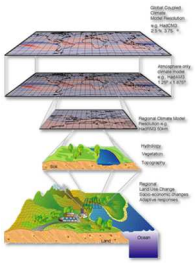
Why do climate modelers care about land surface ?

- Significant impact of terrestrial part to the climate system for:
  - fundamental climate understanding (fluxes of water, C and energy)
  - used in impact and mitigation assessments at various scales

(2010 GCOS Implementation Plan)

→ **Requirements for a consistent long term time series of land cover**





UCL – EARTH & LIFE INSTITUTE 2

5 Terrestrial ECVs in the CCI

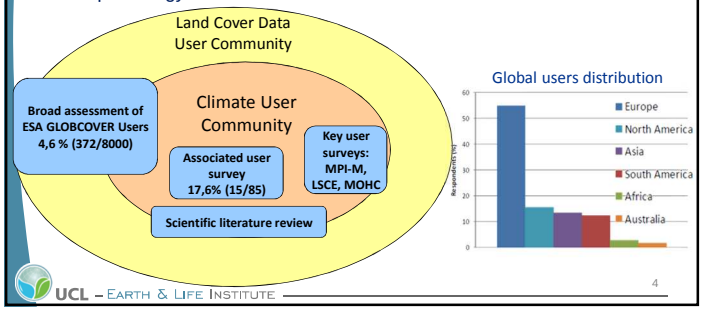
land cover · fire · ice sheets · glaciers · soil moisture

Pierre Defourny, Emilio Chuvieco, René Forsberg, Frank Paul, Wolfgang Wagner
Science Leaders

UCL – EARTH & LIFE INSTITUTE 3

Land Cover for Climate Modeling

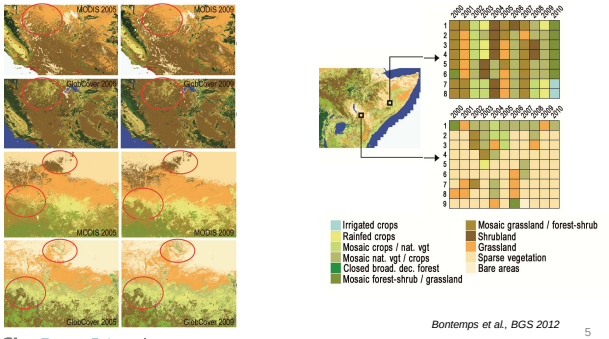
- 6 months dedicated to users consultations
  - Need for stable LC maps over time
  - Need for a dynamic component reflecting change, vegetation phenology



UCL – EARTH & LIFE INSTITUTE 4

Annual or limited time series → inconsistency between LC maps

Very challenging for all global land cover products showing annual variations not related to 'land cover change'

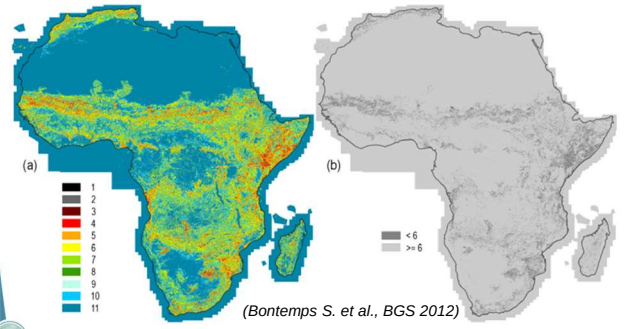


Bontemps et al., BGS 2012

Annual or limited time series : transition zone prone to LC inconsistency

Nbr of occurrences of the same LC class from annual land cover maps

Stable versus less stable region land cover mapping



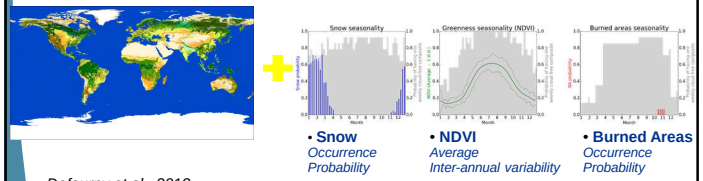
(Bontemps S. et al., BGS 2012)

Revisited land cover concept: **land cover + land surface seasonality**

Land cover can not be the (observed) physical and biological cover on the terrestrial surface (LCCS 2005; GTOS ECV 2009) …

and remains stable and consistent over time (as requested by climate modelers)

→ **Mapping land cover & land surface seasonality**



Defourny et al., 2013

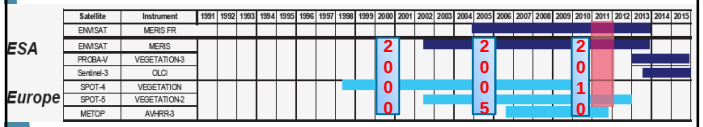
- **Snow** *Occurrence Probability*
- **NDVI** *Average Inter-annual variability*
- **Burned Areas** *Occurrence Probability*

Climatology of 3 variables over 12 y.

Land cover maps for 3 epochs

2010 (2008-2012), 2005 (2003-2007), 2000 (1998-2002)

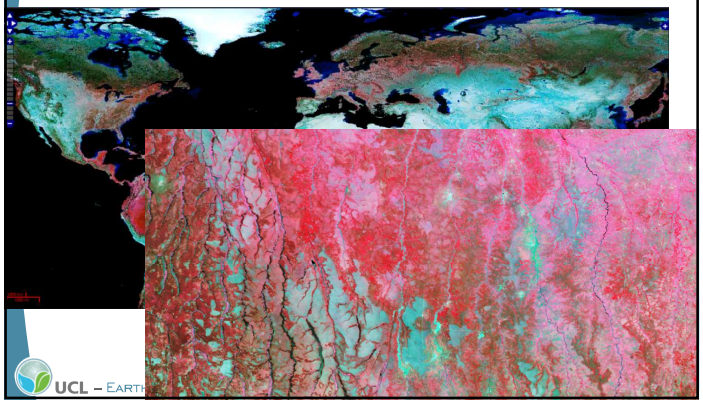
- Input EO time series:
  - Envisat MERIS Full Resolution (near-global every 3-9 days 300 m reflectance in 15 bands (blue to NIR), 2003-2012)
  - Envisat MERIS Reduced Resolution (global every 3 days 1.2 km reflectance in 15 bands (blue to NIR), 2003-2012)
  - SPOT Vegetation 1 & 2 (global daily 1-km surface reflectance in 4 bands (blue to SWIR), 1999-2012)
  - Envisat ASAR WS, IMM & GM from 2005 to 2012



→ *3rd global full archive reprocessing of MERIS (160 TB) + VGT (10TB)*

MERIS 7-d surface reflectance time series (36 TB)

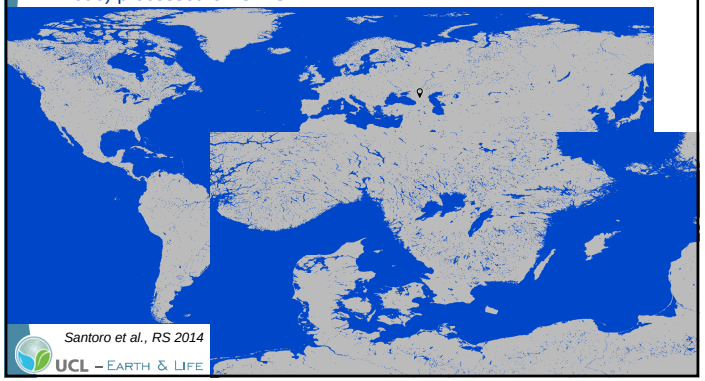
- Full MERIS archive processed in surface reflectance (2003-2012)



UCL – EARTH

Global land/water mask

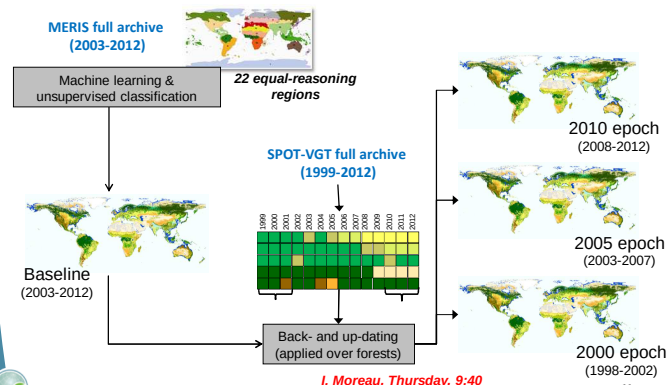
- 8 years of ENVISAT ASAR data (mainly 150 m WS mode, Global Mode) processed on G-POD



Santoro et al., RS 2014

UCL – EARTH & LIFE

Classification in 22 LCCS classes

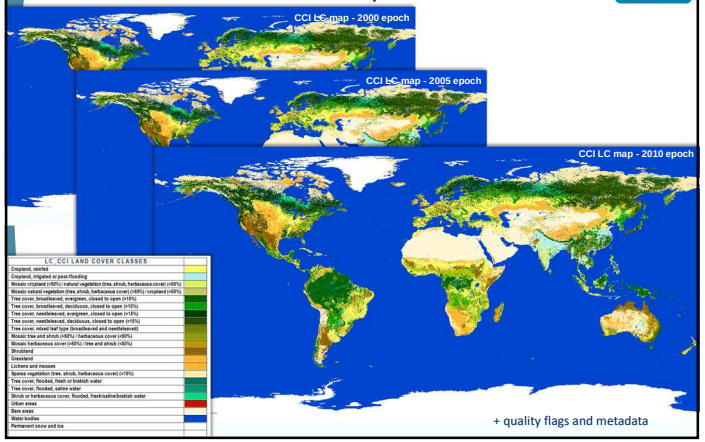


I. Moreau, Thursday, 9:40

UCL – EARTH & LIFE INSTITUTE

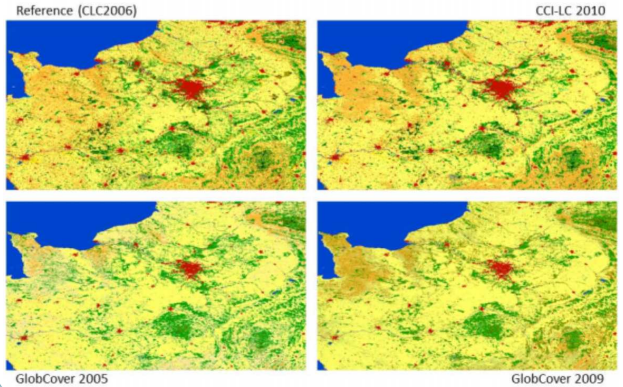
11

2000, 2005 and 2010 CCI Land cover products

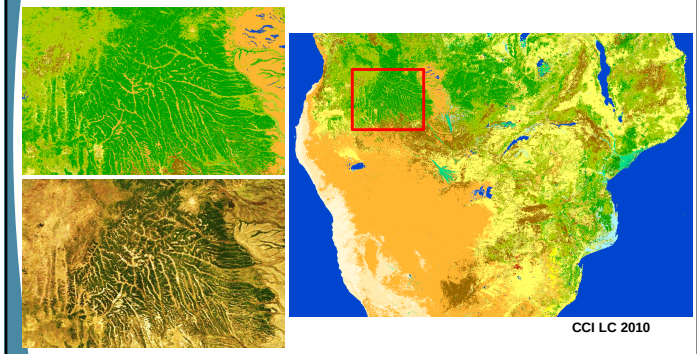


+ quality flags and metadata

CCI Land Cover products
Paris region intercomparison

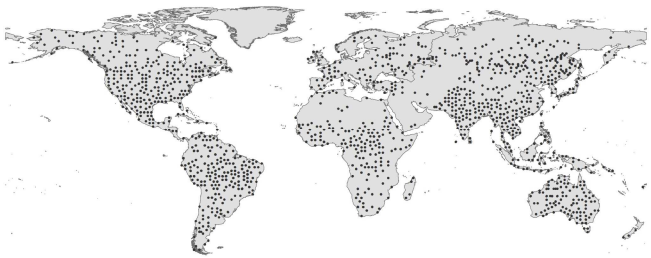


CCI Land cover products
South Africa

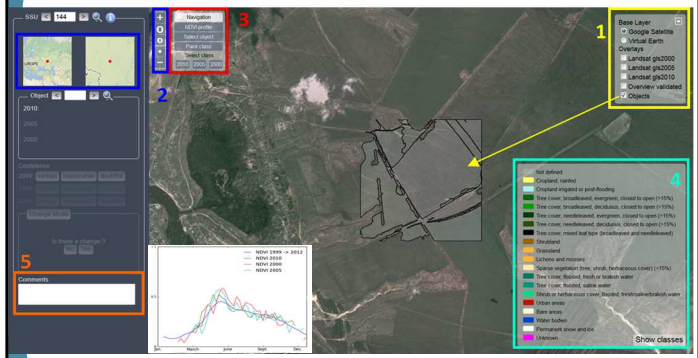


Completion of the multi-epoch CCI LC Validation database

- Network of 19 international experts working on the same interface
  - → 2591 footprints of 900 x 900 m interpreted for each epoch (2000/2005/2010)

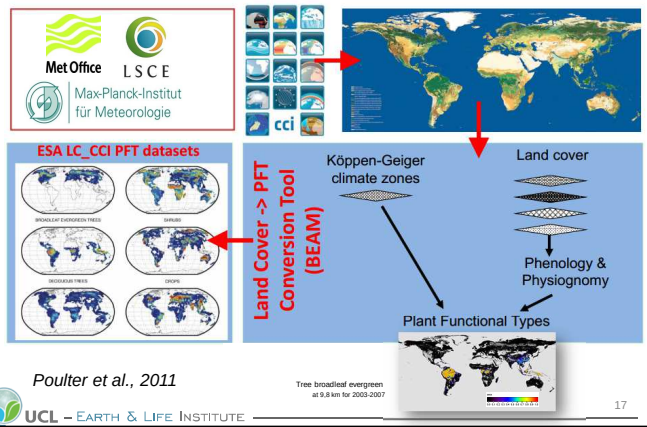


Validation interface



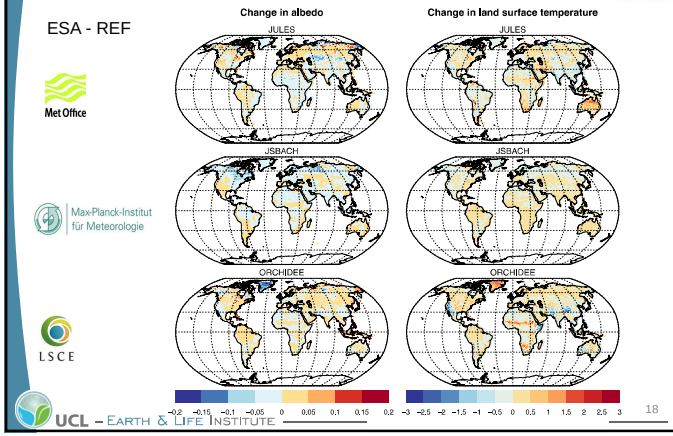
1. Layer box
2. Zooms
3. Tools (navigation, NDVI, select object, paint class)
4. Legend
5. Comments

User tool for climate modelers to convert in Plant Functional Types



Poulter et al., 2011

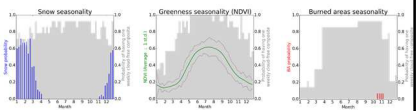
Impact of land cover and cross-walking table on albedo and LST



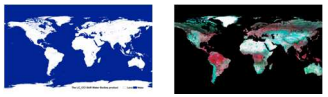
5 CCI LC Datasets

- Stable LC maps for 3 'epochs':
  - 2000: (1998-2002)
  - 2005: (2003-2007)
  - 2010: (2008-2012)

- Land surface seasonality:
  - Snow cover
  - NDVI
  - Burned areas

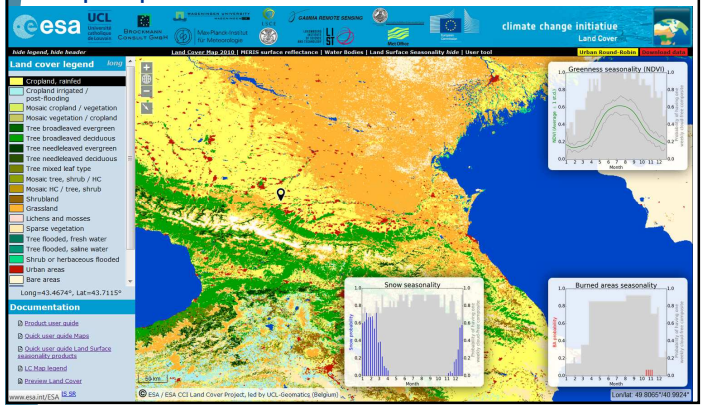


- Global land/water mask
- MERIS Surface Reflectance
- User tool



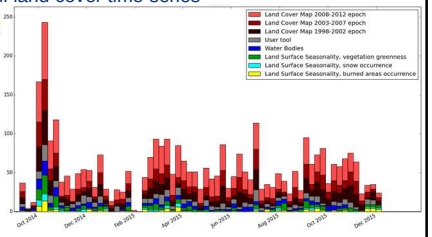
Downloadable or visible on a viewer

- **http://maps.elie.ucl.ac.be/CCI/viewer/index.html**



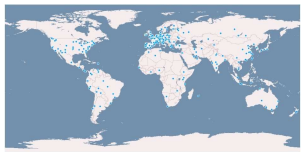
CCI-LC products downloads : 754 LC 2010 5246 Gb products and 209 tools

- More than 300 CCI LC full land cover time series
- 141 CCI land/water mask
- 209 User tools



- 117 NDVI LSS (1552 GB)
- 62 BA LSS (214 GB)
- 52 Snow LSS (307 GB)

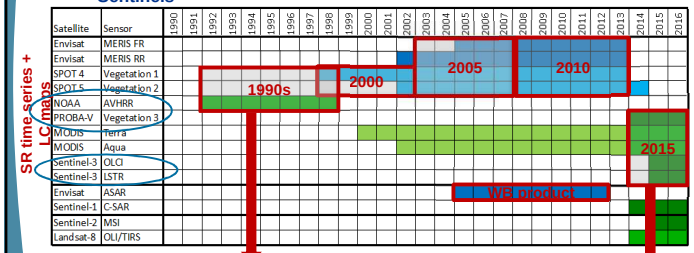
- **MERIS 7-d SR time series**
  - **~ 15 subsets requests**



- Wide distribution of IP localisation

CCI Land Cover: next steps

- **EO data input to further extend in time the LC time series**
  - **7 different instruments including PROBA-V, AVHRR and the Sentinels**



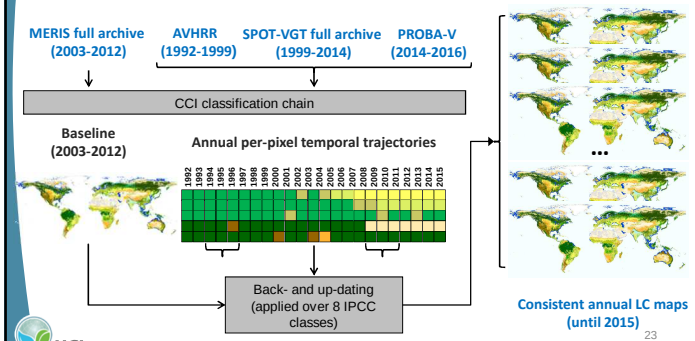
AVHRR archives – 1km HRPT - 1992-1998

PROBA-V – 1 km, 333 m & 100 m 2014 -…

Sentinel-3 – 300 m

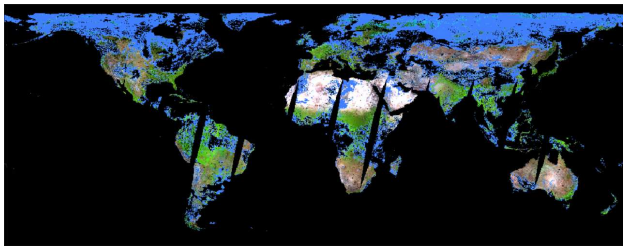
Timeline extension with AVHRR and PROBA-V

- Backdating to 1992 and updating to 2015 based on AVHRR and PROBA-V
- Classification in 22 LCCS classes AND annual change on 8 IPCC classes



PROBA-V to support the LC mapping

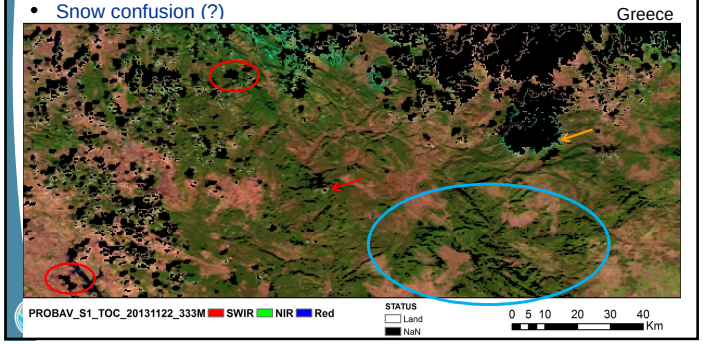
- PROBA-V S1 333 m and 1 km as input for the classification chain and change detection, respectively



S1 333 m - global composite – 18 October 2014

PROBA-V S1: very good geometry but cloud screening improvement much needed

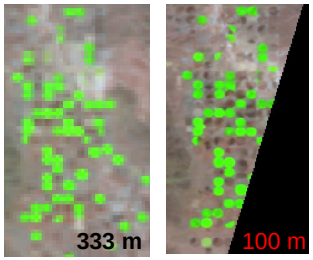
- Over-estimation of cloud shadows
- Under-estimation of clouds borders
- False clouds detections in shadows of mountainous areas
- Snow confusion (?)



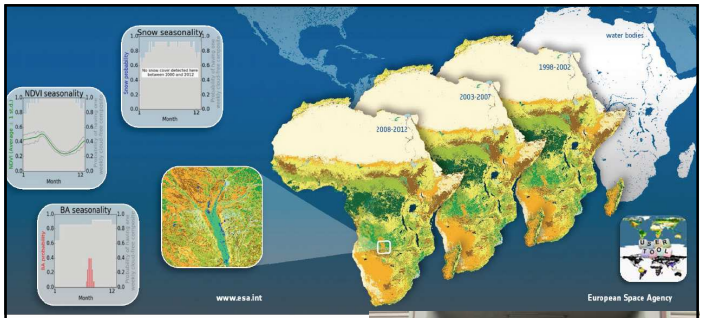
PROBA-V 100 m to support decametric global land cover

- CCI LC over Africa using Sentinel-2 & Landsat 8 time series
- Classification results expected to be much constrained by availability of cloud free observations

→ Daily global missions at 100 m to 300 m are key requirements for annual global land cover mapping



UCL – EARTH & LIFE INSTITUTE 26



Thank you for attention

UCL – EARTH & LIFE INSTITUTE